

Forest Fires Practical Handout 2

COURSEWORK DETAILS			
C/W NUMBER	2 nd	CONTRIBUTION	15 % of the module final mark
C/W TITLE	Forest Fire Detection and Suppression Cooperative Agents		
C/W TYPE	Individual Practical		

LEARNING OUTCOMES
Upon completion of this piece of coursework, a student will be able to: <ul style="list-style-type: none">▪ understand in depth the issues and the difficulties involved when building a multi-agent system, such as agent communication languages, interactions protocols, language used etc.▪ to use an existing library to construct FIPA ACL like messages and implement an interaction protocol▪ propose a suitable agent architecture to perform a problem solving task▪ build a simple prototype of a multi agent system on a multi-agent simulation platform (NetLogo)▪ evaluate the design choices made based on simulation results.

ASSESSMENT CRITERIA	
▪ Correctness, originality and justification of the proposed agent architectures	25%
▪ Correctness and justification of the cooperation protocols proposed	25%
▪ Implementation and code documentation	35%
▪ Analysis and presentation of experimental results	5%
▪ Presentation of the report (clarity, structure)	10%

DETAILED DESCRIPTION

Forest Fire Detection and Suppression Cooperative Agents (The FFDSCA System)

An advanced forest service has a number of autonomous agents that operate in its environment. These agents are:

- ground units (or simply units) that are capable of extinguishing fires
- scouts that are agents that are not carrying any water but instead a set of sensors to detect fire.

The forest environment is shown in the figure below (Figure 1). Agents listed above have different abilities; however they are able to communicate by exchanging FIPA ACL messages.

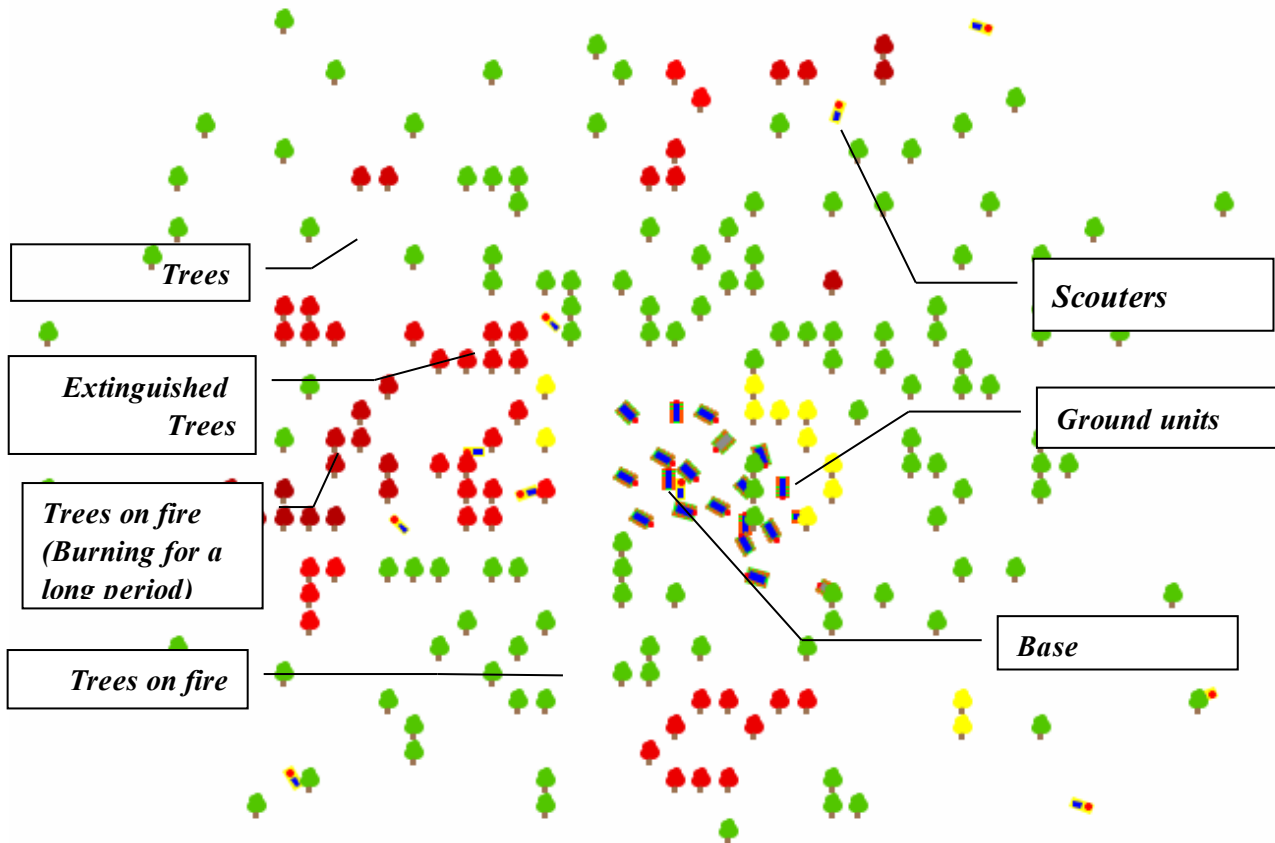


Figure 1: The Forest Simulation Environment

Ground units are fire extinguishing autonomous vehicles that are able to travel around the forest environment and put out any fires they detect on their path. These units are equipped with the latest GPS technology and can report their exact position, as well as travel towards a specific destination. The later can be either specific coordinates or another vehicle in the environment. Ground units have the necessary equipment in order to communicate with any other agent in the environment. Since these units have a significant size, collisions between ground units must be avoided. Additionally the units cannot go over areas that are on fire.

Scouters are light weight, small size autonomous vehicles that can move around the environment very fast. Although they do not have the ability to extinguish a fire, they have sensors to detect fires in the environment as well as the ability to communicate with any other agent in the environment. The only obstacle for scouts is trees (areas) on fire; they are small enough to co-exist in the same area with ground units or other scouts.

The agents mentioned above cooperate in order to extinguish fires in the forest. Their cooperation is rather simple. Scouter agents patrol the forest looking for spots of fire. When such a spot is detected, scouts broadcast a message to all unit agents reporting the location of the spot (coordinates) and remain in the area until the fire is out (either an agent comes and puts out the fire, or the tree burns completely). Ground units remain idle until they receive a message, upon the reception of which they start travelling towards the fire spot in order to extinguish the fire. On their way to the spot, they put out any fires that are found on their path.

The ground unit agents were modelled as hybrid agents where the reactive layer deals with the low-level functions of the agent, like extinguishing a fire upon detection, reloading with water if the agent's tank become empty, moving towards a specific location etc. The proactive layer of the agent is modelled in a PRS-like style, where intentions of the agent are stored in a stack and are maintained until a condition becomes true (check the corresponding document found in the Web page of the course for details). The agent also maintains a set of beliefs, where it stores information required for accomplishing its tasks and an incoming-queue where it receives all messages (see document describing FIPA ACL like communication facilities in NetLogo available through the web page of the course).

The ground unit agent starts with an initial intention of "find-target-fire". This intention always exists as the first element in the intention stack of the agent. Depending on the messages received or conditions in the environment, the agent "pushes" new intentions in its intention stack that are executed by the interpreter.

The scouter agents are also modelled as hybrid agents. Their reactive layer is merged in their "search-fire" behaviour; they are exploring the forest space using a very simple reactive architecture. Their proactive layer on the other hand, is responsible initiating the search for a fire spot and for broadcasting the appropriate message when the spot is found. Initially scouter agents have the intention "look-for-fires".

The agents described have been implemented as a model in the NetLogo platform, (as shown in Figure 1) and the code of the model is provided through the web page of the course. The model contains facilities for monitoring the time and cost of the performed experiment as well as running the experiment with a varying number of agents, as well as the necessary code for communication and for building BDI style agents in NetLogo.

- 1) State why you believe the hybrid design was adopted for the agents in the forest service. What were the problems you would anticipate if the agents were modelled according to the BDI architecture?
- 2) In the implementation provided all ground unit agents rush to the location reported by the first scouter agent that detects a fire. This is a rather naive approach that causes some efficiency problems. A simple improvement is to modify the ground unit appropriately so that it selects the spot location that is closer to its current location. Implement this improvement and run a few experiments to demonstrate that this approach has an effect on the efficiency of the system.
- 3) Even with the improvement mentioned above, quite a few agents might direct themselves to a specific fire spot in order to extinguish the fire. Propose and briefly describe a suitable cooperation protocol between scouts and ground units that could be employed to efficiently extinguish fires and justify your answer. Describe in detail all the FIPA ACL messages exchanged by the agents engaged in the interaction you proposed.
Note: In this rather limited environment, you may assume that agents share a common ontology and language, so there is no need to specify them explicitly.
- 4) Taking into consideration all the above, provide detailed descriptions of the new, extended scouter and ground unit agent architectures so that they can cooperate under the protocol you described in Q. 3. In both cases your descriptions should be as detailed as possible, including the beliefs, intentions of the agent, etc.
- 5) Implement the scouter and ground unit agents in NetLogo and run a few experiments to demonstrate the correctness of your design choices. Briefly state possible improvements to your agent design and how these could be implemented (without necessarily implementing them).

SUBMISSION

Students are expected to submit:

- A written report that contains
 - Appropriate answers to all the questions that appear above, properly justified.
 - Descriptions of the experiments carried out.
 - A printout of the code they have implemented, **highlighting in bold characters the changes implemented to the original code given. Students should NOT submit a printout of the whole NetLogo model, but just include only those parts to which changes were made.**
 - Students are expected to submit **two** NetLogo models and the corresponding printouts: the first model will implement the answer for Q2 and the second the answer for Q5.
 - References
- A floppy disc containing the documented NetLogo code. In all cases the results obtained by the submitted code should match those appearing in the report.

The submitted code should also be sent by e-mail to the e-mail address of the instructor. Please include the code in a zip file (compressed) attached to the e-mail.